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# China Report

SCIENCE AND TECHNOLOGY

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21 NOVEMBER 1986

# CHINA REPORT

## SCIENCE AND TECHNOLOGY

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NATIONAL DEVELOPMENTS

KANG SHIEN AT DAQING PETROCHEMICAL COMPLEX CEREMONY

OWO41408 Beijing XINHUA in English 1351 GMT 4 Aug 86

[Text] Daqing, 4 August (XINHUA)--The completion and inauguration of the first-phase project of the Daqing Petrochemical complex were marked at a ceremony in this oilfield today.

The complex will be able to produce 300,000 tons of ethylene a year when the whole project is completed in 1988.

The ceremony was attended by 1,000 people, joined by more than 160 guests from Japan, the United States, Britain and Federal Republic of Germany.

Most installations of the complex, 12 plants and 71 auxiliary plants, were imported from these 4 countries.

Ethylene is the primary raw material for producing textiles, plastic products, building materials, chemicals and other consumer goods. Ethylene output is therefore regarded as an indicator of the development of a country's petrochemical industry.

With an investment of 4.2 billion yuan, the Daqing petrochemical complex, a computerized enterprise, uses light hydrocarbon from the Daqing oilfield as its main raw material.

It is another key construction project China has undertaken after three other ones: The Gezhouba Dam on the middle reaches of Hubei Province; the Baoshan Steelworks in Shanghai; and a railway line between Yanzhou, Shandong Province, and Shijiusuo Port in the same province.

A total of 2.64 billion yuan has been spent on the first-phase project. The first 5 commissioned plants and other assistant facilities cover 150 hectares and involve 50,000 sets of equipment. The pipelines there total about 1,600 kilometers in length.

The major plant of the first-phase project is 36 meters high, with the largest pipeline being 1.1 meters in diameter and the smallest, 8 millimeters.

The first five commissioned plants will produce 200,000 tons of polyethylene granule annually, the basic raw material for the plastics industry, as well as other raw materials. This will increase China's per-capita amount of plastics to 1.5 kilograms from 0.9 in 1980.

The first-phase project will also raise China's ethylene output by 50 percent, to reach 900,000 tons a year.

Construction of the Daqing petrochemical complex is being undertaken by 50,000 workers.

The State Council, China's highest governing body, today sent a message of congratulations to the complex, calling it a new success in the country's modernization program.

State councilor Kang Shien cut the ribbon for the operation of the first-phase project and extended greetings to the builders on behalf of the State Council.

Attending the ceremony were leading officials of the China Petrochemical Corporation, Heilongjiang Province and other government departments, as well as diplomatic envoys and representatives of 40 firms and banks from the four foreign countries.

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CSO: 4010/1004

NATIONAL DEVELOPMENTS

NEW SHANGHAI INDUSTRIAL CENTER UNDER CONSTRUCTION

OWO51030 Beijing XINHUA in English 0608 GMT 5 May 86

[Text] Beijing, 5 May (XINHUA)--A micro-electronics center, which aims at attracting foreign investment and import of foreign technology, is under construction in Shanghai, according to the WEN HUI BAO, a Shanghai-based daily.

The Caohejing Industrial Center, 11 kilometers southwest of the city will focus on developing computers, large-scale integrated circuit, optical-fibre telecommunications, laser and other micro-electronic industries.

The new industrial area has attracted business persons from a dozen of countries, including Federal Germany, Japan and the United States.

It covers 1.7 square kilometers, with research institutes, parks and "smokeless" enterprises in the surrounding.

Projects planned include a 10,000-line telephone exchange, a 220,000 volt-transformer station, and three gas tanks, factories, as well as office buildings, information centers, hotels, trade, commerce and banking facilities.

Local officials expect enterprises with exclusive foreign capital, joint ventures and cooperative businesses to be set up in the new industrial area, the WEN HUI BAO said.

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CSO: 4010/1004

NATIONAL DEVELOPMENTS

RENMIN RIBAO REPORTS MICROCOMPUTER INDUSTRY PLANS

OWO21240 Beijing XINHUA in English 1207 GMT 2 Jul 86

[Text] Beijing, 2 July (XINHUA)--To meet internal needs, China must increase the output of microcomputers, Zhang Xuedong, vice minister of the electronics industry, said in an article printed in today's PEOPLE'S DAILY.

During the Seventh 5-Year Plan period (1986-1990), he said, microcomputer needs are expected to double. This year, there are already orders for 10,000 of the model 0520c "changcheng" (great wall) microcomputer. More than 54,200 computers were installed last year.

"Self-sufficiency in microcomputers can save hard currencies for the state, facilitate repair and technical services, and improve efficiency of the clients' investment," he explained.

At a recent national meeting, a plan was drawn up for the industry, which will be administered by the Ministry of Electronics Industry.

According to the plan, the industry will manufacture simple microcomputers first and then complicated ones. Emphasis will be on peripheral equipment, including disc drives and monitors.

In 1990, the value of peripheral equipment is expected to be 2 billion yuan, accounting for 33 percent of the total computer industry. The state will support the industry by providing tax breaks and loans.

The computer industry employs 90,000 workers, including 17,000 technicians. Over the past few years, it imported assembly lines with an annual capacity of 50,000 microcomputers and developed some updated products, including Chinese processing systems.

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CSO: 4010/1004

NATIONAL DEVELOPMENTS

TIANJIN TO BECOME ELECTRONIC MACHINERY BASE

OW211116 Beijing XINHUA in English 1050 GMT 21 Aug 86

[Text] Tianjin, 21 August (XINHUA)--Tianjin, a major north China industrial and port city, has been chosen to become an electronic controlled machinery development base.

The endeavor will be guided by a joint committee of the Chinese Ministries of Machine Building and Electronics, which was formed today.

A committee official said that the move aims at meeting the challenge of the galloping technological revolution, which is focused on spreading the use of electronic computers.

Work will be done to introduce microelectronic technology into the manufacture of machine building, electronic appliances and instruments and meters to improve the traditional products.

The electronic controlled machinery will cover a complete range, from production lines to home appliances and toys, which will help open a new vista for raising productivity and enriching the people's life, the official said.

The first projects will begin in the latter half of this year, and included will be development of duplicators and electronic medical apparatus, numerical controlled machine tools, renovation of old type machine tools and development of information management systems, the official said.

A number of enterprise groups and production-research schemes will be formed to facilitate the experimental projects, he said.

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CSO: 4010/1004

NATIONAL DEVELOPMENTS

SATELLITE LAUNCHING SERVICE SAID 'PURELY COMMERCIAL'

OW271033 Beijing XINHUA in English 0715 GMT 27 Sep 86

[Text] Beijing, 27 Sep (XINHUA)--China's satellite launching service is purely a commercial venture, and the country has no intention to take advantage of it to acquire foreign technological information. The country is willing to invite customers who worry about the release of their satellite technology to send experts to China to supervise the launches, said Sun Jiadong, vice-minister of space industry, in an interview with PEOPLE'S DAILY.

In a report today, the paper reviewed the progress of China's space technology and policies for satellite launching service.

Over the past year, Swedish and American firms have requested the launching of six satellites using China's "Long March 2 and 3" carrier rockets, the paper added.

Australia, Brazil, Britain, Canada, and the Netherlands as well as U.S. telecommunications and broadcast companies have held direct or indirect discussions with China about satellite launches.

China launched its first man-made satellite in 1970. Since then, it has sent another 17 into the space, including two earth synchronous satellites.

China is now able to handle international orders to launch 10 to 12 commercial rockets and is developing carrier rockets with greater thrust to meet the needs of the world market, the paper said.

China will charge at least 15 percent less than the rates offered by foreign countries for the service, and its People's Insurance Company will offer low premiums to those using the launch.

China's space industry minister will complete a comprehensive quality control program this year to ensure the success of launches.

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CSO: 4010/9

NATIONAL DEVELOPMENTS

SATELLITE RETURNED TO EARTH ON SCHEDULE

OW110909 Beijing XINHUA in English 0856 GMT 11 Oct 86

[Text] Beijing, October 11 (XINHUA)--Today a land resource survey satellite carrying valuable technological data returned to China on schedule.

The head of China's satellite launch telemetry and control system department told XINHUA that the satellite was launched on Monday by a "Long March-2" carrier rocket at Jiuquan launching center, northwest China.

The People's Insurance Company of China provided economic insurance for the launch.

The official said, "all instrumentation on the satellite worked normally and it returned to the earth as planned."

He added, this is China's 19th satellite since the first launching in 1970, which include satellites for telecommunications and broadcasting, scientific exploration and technical experimentation.

The valuable data obtained by this satellite will be used for land surveillance, mineral prospecting, environmental protection, and other uses.

Min Guirong, president of the Chinese Academy of Space Technology, said, in an exclusive interview with XINHUA, "China has launched and recovered eight satellites with a 100 percent success rate since 1975."

"The satellites worked in planned orbits for three or five days and then all returned on schedule," Min said.

"Compared with other satellites," Min said, "the newest one has been fitted with special technology, and its photo taking capacity was improved, resulting in better pictures."

Showing clear satellite pictures, the specialist said, "the satellite pictures and other data will be used in surveying national land, prospecting resources, drawing inland and coastal maps and planning new cities.

In order to meet the needs of its modernization program, China will redouble its efforts in developing its space industry, which includes speeding up the development of practical satellites for use in communications, meteorology and the surveillance of land resources.



## NATIONAL DEVELOPMENTS

### BRIEFS

SHANGHAI'S NEW DATA SYSTEM--A management, production, and marketing data collecting and distributing system developed by the Shanghai Fasteners Company and Shanghai's Jingju County Welding Materials Technology Institute recently passed assessment tests. This computer-controlled collecting and distributing data system is very practical. Better economic results have been attained after the application of the system. [Text] [Shanghai City Service in Mandarin 1000 GMT 17 Aug 86 OW] /12232

GUANGDONG ELECTRONICS INDUSTRY--During the Seventh 5-Year Plan period, the electronics industry of Guangdong Province will lay stress on the development of consumer electronic products. Since the beginning of 1980, our province has begun making radio recorders and television sets. Last year, the output of television sets reached 700,000 sets and the output of radio-recorders 2.8 million sets, ranking first in the whole country. Our province, Shanghai, Beijing, and Jiangsu have become the bases of the electronics industry. By 1990, the annual output of television sets will reach 1.3 million sets, the great majority of which will be color television sets. The annual output of radio-recorders and radios after 5 years will respectively be 400 percent and 175 percent greater than last year. Our province has now not carried out batch processing of videocorders, but after 5 years, the annual output will reach 130,000 sets. [Summary] [Guangzhou Guangdong Provincial Service in Mandarin 0300 GMT 1 Sep 86 HK] /12232

BEIJING PHENOL ACETONE EQUIPMENT--A large phenol acetone production assembly, the first of its kind in China and a key project of Beijing Municipality, has been completed and formally went into operation at the Yanshan Chemical Industrial Plant on 20 September. This apparatus, with an annual production capacity of 80,000 tons of phenol acetone, was built by the state with an investment of about 150 million yuan. Upon going into operation, the equipment can earn 100 million yuan of profits for the state every year. [Summary] [Beijing BEIJING RIBAO in Chinese 21 Sep 86 p 1 SK] /12232

HUNAN ELECTRONIC INDUSTRY--The provincial Electronic Industry Bureau has strengthened macroeconomic control and guidance over the enterprises which have been transferred to a lower level and has done a good job in coordinating work and providing services. This has resulted in a new situation in scientific research and production for the whole bureau. By the end of September, the bureau had completed scientific research on 31 items, and its industrial output value reached some 310 million yuan. [Summary] [Changsha Hunan Provincial Service in Mandarin 0100 GMT 3 Oct 86 HK] /12232

SHANDONG EQUIPMENT INSTALLATION--Beijing, 12 September (XINHUA)--A fertilizer plant in Shandong Province replaced an important piece of equipment today without stopping production. A new 325-ton tower will make it possible for the Qilu Petrochemical Company to produce 300,000 tons of ammonia a year. The replacement operation, which was the first in China, saved a loss of more than 1 million yuan (270,000 U.S. dollars). [Text] [Beijing XINHUA in English 1059 GMT 12 Sep 86 OW] /12232

SICHUAN PRINTED CIRCUIT PRODUCTION--Chengdu, 27 September (XINHUA)--A precision multi-layer printed circuit board production line has been put into operation in Chengdu, capital of southwest China's Sichuan Province. The project was completed in just 15 months by an Australian company. The production line can produce 30,000 square meters of double-faced precision printed circuit boards with 2 to 14 layers to be used in space technology, and electronic instruments and meters. The Xinxing Instrument Factory has received letters and cables from a dozen countries and regions including the United States, Japan, Federal Germany and Hong Kong, asking for the products. The first order has already come from Australia. [Text] [Beijing XINHUA in English 1611 GMT 27 Sep 86 OW] /12232

PRC SOFTWARE PROTECTION LAWS--Beijing, 21 October (XINHUA)--China is preparing a law to protect the integrity of advanced foreign and domestic software, a senior official said here today. Xie Gaojue, vice-minister of the electronics industry, told foreign participants at the Sixth Business Leaders Symposium held here at the ministry and the Ministry of Posts and Telecommunications are negotiating with foreign companies on the import of advanced digital telephone exchanges. The two ministries are cooperating to draft regulations concerning usage of the equipment, he said. Software has high-priority in the development of China's electronics industry during the Seventh 5-Year Plan period (1986-1990), and the new law is expected to help promote China's software technology, the minister noted. Meanwhile, China will continue to import advanced software technology and protect it with the law. [Text] [Beijing XINHUA in English 1511 GMT 21 Oct 86 OW] /12232

CSO: 4010/1004

# APPLIED SCIENCES

## BIFILAR-HELIX WIGGLER FOR FREE-ELECTRON LASER DESCRIBED

Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 6, No 8, Aug 86  
pp 673-678

[Article by Chu Cheng [5969 2052], Lu Zaitong [7120 6528 6639], Shi Ruigen [2457 3843 2704], Zhang Lifan [1728 4539 5358], and Hu Yu [5170 3558] of the Shanghai Institute of Optics and Fine Mechanics, the Chinese Academy of Sciences; first paragraph is source supplied abstract]

[Text] Abstract: We have developed a bifilar helix wiggler used in a Raman free electron laser and measured its operating characteristics. Using this wiggler as a pump source, we have obtained free electron laser radiation and carried out preliminary parametric studies.

### I. Introduction

Bifilar helix wigglers<sup>1-3</sup> have recently been used as a pump source for the Raman free electron laser. The right-circularly polarized field produced by the wiggler interacts with the magnetic field that confines the electron beam. Under the proper combination of the parameters, this interaction effectively pumps the free electrons and leads to a large laser gain and a high quantum efficiency. We applied this pumping technique to a Raman free electron laser<sup>4</sup>. Experiments show that the bifilar helix wiggler can not only provide a laser output like the iron ring wiggler, and it is also more convenient for parametric studies.

### II. Determination of the Principal Parameters of a Bifilar Helix Wiggler

The two principal parameters of a right-circularly polarized wiggler field are the intensity and the period. We first examine the intensity. For a bifilar helix with current  $I$ , shown in Figure 1, the magnetic potential  $\varphi$  in Gaussian units is given by<sup>5</sup>:

$$\varphi = \varphi_I + \varphi_{-I} = -\frac{16\pi I}{c\lambda_w} \sum_{n=1,3,5,\dots}^{\infty} K'_n(nk_w a) I_n(nk_w r) \sin(\theta - k\omega z), \quad (1)$$

where  $I$  is the current flowing through the winding,  $\lambda_w$  is the period (pitch),  $k_w \equiv 2\pi/\lambda_w$ ,  $(r, \theta, z)$  are the cylindrical coordinates, and  $K_n$  and  $I_n$  are Bessel functions. From Eq. (1), the magnetic field components are found to be

$$\begin{cases} B_r = \frac{8Ik_w^2 a}{c} \sum_{n=1,3,5,\dots}^{\infty} K'_n(nk_w a) \cdot nI'_n(nk_w r) \sin n(\theta - k_w z), \\ B_\theta = \frac{8Ik_w a}{cr} \sum_{n=1,3,5,\dots}^{\infty} K'_n(nk_w a) \cdot nI'_n(nk_w r) \cos n(\theta - k_w z), \\ B_z = -k_w r \cdot B_{\theta 0} \end{cases} \quad (2)$$

On the axis ( $r = 0$ ), properties of the Bessel functions dictates that  $I'_1(0) = 1/2$ ,  $I'_3(0) = 0$ , ... Therefore, only the first terms ( $n = 1$ ) of the coefficients of  $B_r$  and  $B_\theta$  are nonzeros. The  $n = 1$  terms of  $B_r$  and  $B_\theta$  are also the same.  $B_z$  is evidently zero at  $r = 0$ . We therefore have

$$\begin{cases} B_r|_{r=0} = B_w \sin(\theta - k_w z), \\ B_\theta|_{r=0} = B_w \cos(\theta - k_w z), \\ B_z|_{r=0} = 0, \end{cases} \quad (3)$$

where the magnitude of the magnetic field is

$$B_w = \frac{2}{5} k_w I [k_w a k_0(k_w a) + k_1(k_w a)], \quad (4)$$

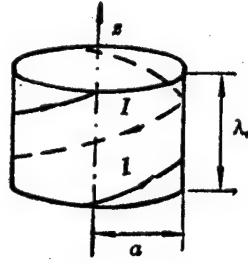


Figure 1. Schematic of a bifilar helix winding ( $I$  is the current,  $\lambda_w$  the pitch,  $a$  the radius)

In (4) the unit of  $I$  has been changed to Ampere and the unit of  $B_w$  is Gauss. Near the axis ( $k_w r \ll 1$ ), we have

$$B_r \approx B_w \sin(\theta - k_w z) + \alpha \cdot B_w \sin 3(\theta - k_w z), \quad (5)$$

$$B_\theta \approx B_w \cos(\theta - k_w z) + \beta \cdot B_w \cos 3(\theta - k_w z), \quad (6)$$

where

$$\alpha = 3 \cdot \frac{K'_3(3k_w a)}{K'_1(k_w a)} \cdot \frac{I'_3(3k_w r)}{I'_1(k_w r)} \approx \frac{r^2}{a^2}, \quad (7)$$

$$\beta = 3 \cdot \frac{K'_3(3k_w a)}{K'_1(k_w a)} \cdot \frac{I_3(3k_w r)}{I_1(k_w r)} \approx \frac{r^2}{a^2}. \quad (8)$$

For actual computation equations (3)-(8) are too complex. We therefore use the approximate formula of Blewett<sup>6</sup>. For  $a/\lambda_w > 0.2$   $I$  is given by

$$I = 0.246 \cdot \exp(5.68a/\lambda_w) \cdot \lambda_w \cdot B_w, \quad (9)$$

where the current  $I$  is in Amperes, the pitch  $\lambda_w$  is in centimeters, and the magnetic field  $B_w$  is in Gauss. We constructed our wiggler using copper wires with a circular cross-section. The dimensions are shown in Figure 2(a). The field intensity  $B_w$  is

$$B_w = \frac{8.13}{\pi} \cdot \frac{I}{\lambda_w r^2} \int_{a_1}^{a_2} \sqrt{r^2 - (r + a_1 - a)^2} \exp(-5.68a/\lambda_w) da, \quad (10)$$

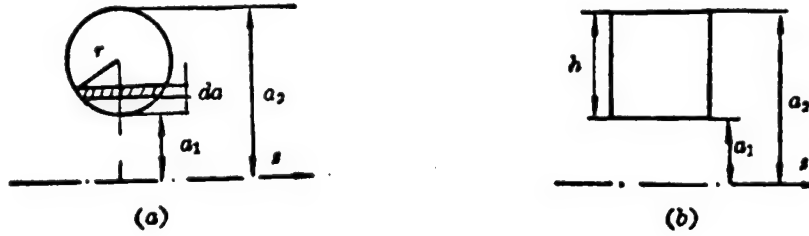


Figure 2. Schematic of finite-dimension wire used in making bifilar helix winding  
(a) circular-section wire; (b) rectangular-section wire

Substituting the data for the straight section ( $r=0.2\text{cm}$ ,  $a_1=1.5\text{cm}$ ,  $\lambda_w=2.2\text{cm}$ ) into (1) and performing the numerical integration, we have

$$B_w = 0.0237I, \quad (10)'$$

As a comparison, the field intensity for a flat wire is

$$B_w = 0.716 \frac{I}{h} \left[ \exp\left(-\frac{5.68}{\lambda_w} a_1\right) - \exp\left(-\frac{5.68}{\lambda_w} a_2\right) \right], \quad (11)$$

For a square wire (using the same,  $r$ ,  $a_1$  and  $\lambda_w$ ), we have

$$B_w = 0.0240I, \quad (11)'$$

The difference is less than 1.3 percent. For the convenience of winding, we used wires with a circular cross-section. For a two-layer winding,  $B_w = 0.0321 I$ . For a three-layer winding,  $B_w = 0.035 I$ . The changes are small for more than three layers. The coil is driven by a conventional impulse current generator. Theoretical calculation shows that the peak current is  $I_m = 12.7 u_0$  ( $u_0$  is the charging voltage) and the rise time is 0.5 msec. The relationship between the field intensity  $B_w$  and the charging voltage  $u_0$  is

$$B_w(\text{Gauss}) = 0.4u_0(\text{V}). \quad (12)$$

For a maximum  $B_w$  of 1 KG, the charging voltage is 2.5 kV.

Next we consider the pitch  $\lambda_w$  of the wiggler. Since the accelerator voltage of our electron pulse was somewhat too low (0.5 MeV), we had to carefully choose the parameters. We wish to control the laser wavelength in the millimeter range (<1 cm) while at the same time ensure that the wiggler field imparts enough transverse velocity to the electron beam so that the gain is higher than the threshold ( $\beta_{\perp} \approx 0.2$ , corresponding to the optimum gain region of the Jackson setup<sup>1</sup>). Based on the principle of free electron laser oscillation due to the cross-over of the pump shifted negative energy static beam mode and the electromagnetic dispersion curve, and taking into account the finite length of the waveguide, we derived the frequency of the laser radiation.

$$\omega = \gamma_z^2 \left( k_w v_z - \frac{\omega_p}{\gamma_z} \right) \left[ 1 \pm \left\{ \beta_z^2 - \frac{\beta_z^2 \omega_{c0}^2}{\left[ \frac{\omega_p}{\gamma_z} - k_w v_z \right]^2 \cdot \gamma_z^2} \right\}^{1/2} \right], \quad (13)$$

where  $\gamma_z \equiv \frac{1}{\sqrt{1-\beta_z^2}}$ ,  $\beta_z \equiv \frac{v_z}{c}$ ,  $v_z$  is the axial velocity of the electron,  $c$  is the speed of light,  $k_w \equiv 2\pi/\lambda_w$ ,  $\lambda_w$  is the pitch of the wiggler,  $\omega_p \equiv \sqrt{4\pi n e^2 / \gamma_z m}$  is the plasma frequency of the electron beam in a coordinate system with a velocity  $v_z$ ,  $n$  is the electron beam density,  $m$  is the mass of the electron beam,  $e$  is the electron charge and  $\omega_{c0}$  is the cutoff frequency. Simultaneously solving (13) and the transverse velocity  $v_{\perp}$  given by the stable orbit theory (solving a set of transcendental equations), we have

$$v_{\perp} = \frac{\Omega_w v_z}{(\Omega_0 - \gamma_z v_z k_w)}, \quad (14)$$

where  $\Omega_w \equiv e B_w / mc$ , is the cyclotron frequency,  $\Omega_0 \equiv \frac{e B_0}{mc}$ ,  $B_0$ , and  $B_0$  is the guiding magnetic field.

We obtained results on the effects of  $\lambda_w$  on the laser coupling frequency  $f_{TE}$  and the transverse velocity of the electron and the data are shown in Figure 3. The results show that the laser wavelength does not decrease as the wavelength of the wiggler field decreases. In fact, as shown in Figure 3, the laser wavelength increased as  $\lambda_w$  decreased for values of  $\lambda_w$  less than 2.25 cm. This is caused by an increase in the transverse velocity  $\beta_{\perp}$  of the electron as the operating point approached the singular point of the magnetic cyclotron resonance. To obtain a small enough wiggler wavelength while maintaining a sufficiently large transverse velocity (large enough gain), an appropriate value of  $\lambda_w$  is 2.2 cm.

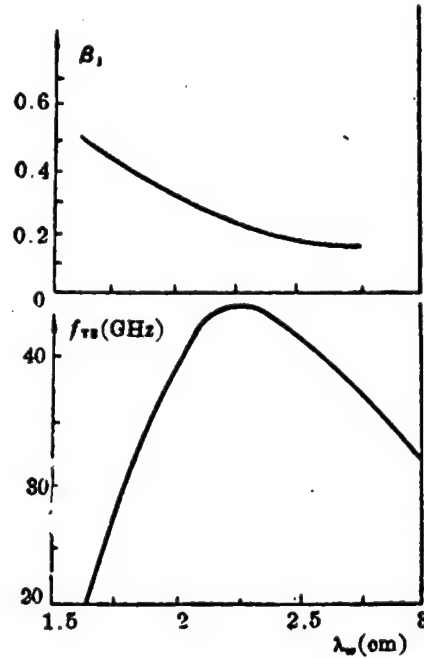


Figure 3. Calculated relationships between  $\beta_{\perp}$  (transverse velocity of electrons) and wiggler period  $\lambda_w$ , and between  $f_{TE}$  (laser frequency of  $TE_{11}$  mode) and  $\lambda_w$

Condition: relativistic factor  $\gamma = 2$ ; beam current  $I = 1$  kA; beam diameter 6 mm; drift tube diameter 20 mm; wiggler amplitude 0.5 KG; guiding field 10 KG

### III. Experimental Results

Figure 4 is a photograph of the bifilar helix wiggler. This wiggler has a pitch of 22 mm and the total length 572 mm contains 26 periods. It is wound on a nylon skeleton with 4 mm diameter cotton yarn covered copper wire in three layers. The central 14 periods are in the straight section and the minimum radius from the axis is 15 mm. In order to avoid perturbation of the electron beam as it enters and leaves the wiggler, the magnetic field at the entrance and exit of the wiggler should be changing gradually to ensure adiabaticity<sup>7</sup>. We made the 7 cycles at the entrance (154 mm, left hand end in Figure 4) and the 5 cycles at the exit (110 mm, right hand end in Figure 4) gradually deviating from the axis in the shape of a trumpet. The radius increased from 15 mm at the straight section to 28 mm at the mouths. From Eq. (9), the magnetic field at the exit will be 0.035 times that at the straight section.

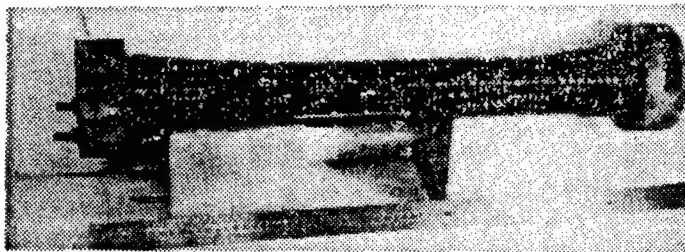


Figure 4. Photograph of the bifilar helix wiggler

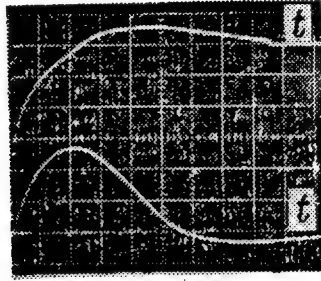


Figure 5. Wavefront of the wiggler field, time scale 0.2 ms/div; voltage scale 0.1 V/cm  
 Upper trace:  $dB_W/dt$  waveform; lower trace:  $B_W$  waveform;  
 condition: capacitor voltage, 2 kV, corresponding to a peak value of wiggler field of 576 Gauss

The upper curve in Figure 5 shows the derivative ( $dB_W/dt$ ) of the wiggler field measured along the axis by a small induction coil (325 turns, average diameter 3 mm). The signal is integrated in a home-made Miller integrator and the resulting waveform of  $B_W$  is shown as the lower curve in Figure 5. The peak value of the pulse is 576 Gauss and the rise time is 0.4 msec. The wiggler field as a function of the charging voltage of the capacitor is shown in Figure 6. As can be seen, the experimental value is smaller than the theoretical value by about 25 percent. We believe the discrepancy is mainly caused by errors in the computed ICR circuit parameters and by the finite size of the small test coil.

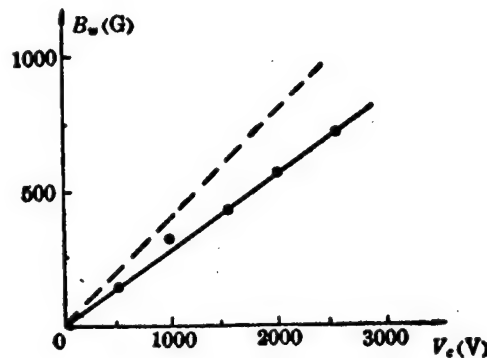


Figure 6. Wiggler field  $B_W$  vs. capacitor voltage  $V$   
 Dash line: calculated from Eq. (12);  
 Dots: measured value

Figure 7 shows the measured wiggler field versus the axial position of a test coil moved along the axis while maintaining a fixed angle  $\theta$ . The results show that the wiggler field is indeed right-circularly polarized, with a period of 22 mm and the positive peak and the negative peak differ by less than 5 percent. The magnetic field in the straight section fluctuates within 10 percent. Measurements also show that the magnetic field of the adiabatic tapering at the mouths gradually decreases from the value at the straight section to approximately zero at the openings.



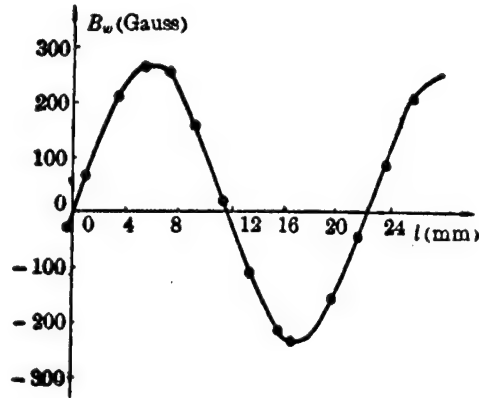


Figure 7. Measured values of the bifilar-helix wiggler along the axial direction ( $l$ )  
Condition: capacitor voltage 1 kV; probe coil 325 turns with average diameter of 2 mm

Using the bifilar helix wiggler and a guidance magnetic field, we pumped a solid cylindrical electron beam and obtained free electron laser output<sup>4</sup> (coherent superradiation amplification mode) under an appropriate parameter combination. The experimental results are shown in Figure 8. The operating parameters are: electron beam energy 0.5 MeV (as measured by the voltage of the electron gun diode), electron beam current 0.2 kA (as measured by the Faraday cup at the end of the drift tube), electron beam persistence time 60 ns, and the electron beam diameter at the end of the 1 meter long drift tube is 6 mm (as measured from beam bombardment). The inner diameter of the drift tube is 20 mm, the radiation is coupled out via the horns with 13 dB gain, and is received by the H surface horn. The radiation is fed into a shielded room via 3 m long K<sub>a</sub> band standard waveguide for temporal and frequency spectral measurement. The laser energy is measured with a carbon calorimeter.

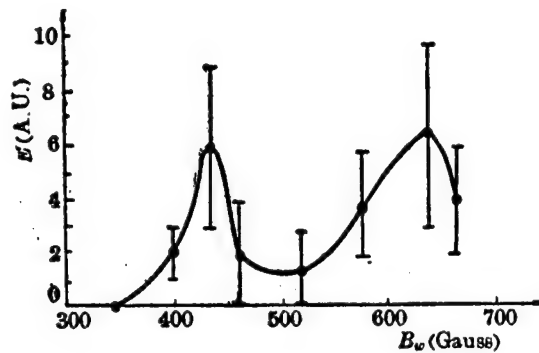


Figure 8. Output laser energy vs. wiggler field  $B_w$ , for solid cylindrical e-beam pumped by the bifilar-helix wiggler  
The guiding field: 10 KG

Figure 8 shows that the radiation is strong only in the 400-650 Gauss region of the wiggler. This is consistent with the observations made at the United States Naval Research Laboratory<sup>1</sup>. The reason is that, for a given steering magnetic field, the region of large laser gain corresponds to the upper and lower limits of the transverse velocity  $\beta_{\perp}$  of the electron, which in turn corresponds to the upper and lower limits of the wiggler field.

Typical parameters of the laser radiation are: 8 mm wavelength ( $K_{\alpha}$  band), 20 ns pulse width, 2 mJ energy, 0.1 MW average power, and 0.1 percent efficiency. These parameters are similar to the results obtained with an iron ring wiggler<sup>4</sup>. This result is still about two orders of magnitude below the performance of similar devices abroad. Improvements will be made in further optimization of the experiment.

This work was conducted under the supervision of Professor Wang Zhijiang. Wang Yunfang and Pan Hua of the Shanghai Institute helped the coil winding, and Shi Jinchuan and Feng Bingfang participated in some of the experiments. The authors also thank Yan Yumin (1985 graduate of the Changchun College of Optics of Fine Mechanics) for extensive preparatory work.

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9698/6091

CSO: 4008/1

APPLIED SCIENCES

BRIEFS

THEORY ON PLATE TECTONICS INTRODUCED--Beijing, 23 Oct (XINHUA)--Chinese scientists believe the earth's crustal movements began somewhere between 1.8 billion and 1.4 billion years ago, and not the 160 million years as generally accepted in the world. Two geologists from Nanjing University say plate movements of the earth's crust occurred as far back as 1.8 billion years ago in the moving continental margin of southeast China and the east Qinling Mountains in northwest China, GUANGMING DAILY has reported. Professors Guo Lingzhi and Shi Yangshen say their conclusion is well supported by ample geochemistry and geophysics data and it is important to the prospecting of energy and mineral resources in the western Pacific. According to the plate tectonics theory of geology, the earth's crust is divided into six major plates moving in relation to each other, thus explaining the shifting of the ocean floor, continental drift, and mountain-building. The Nanjing University professors presented their theory at an international geological symposium Monday in Nanjing, capital of east China's Jiangsu Province. [Text] [Beijing XINHUA in English 0213 GMT 23 Oct 86 OW]

EARTHQUAKE PREDICTION URGED--Beijing, 18 Oct (XINHUA)--Earthquakes which have occurred in China over the past 37 years killed 270,000 people and injured 230,000, a government official disclosed here today. Director of the state Seismological Bureau An Qiyuan said the emphasis of seismological research work should be placed on the forecasting of earthquakes. Since the quake (6.7 magnitude on the Richter scale) in Xingtai, Hebei Province, in 1964, the bureau and its local branches have considered the reduction of the damage from earthquakes as their main task, An said. "Thus, we successfully forecast the earthquake (7.3 magnitude on the Richter scale) in Haicheng, in northeast China's Liaoning Province in 1975, saving probably 100,000 lives," An said, adding that that was the first effective forecast in the history of seismological science in the world. However, the bureau failed to forecast the Tangshan quake (7.8 magnitude, killing 240,000 and injuring 160,000), he lamented. Both the successes and failures have all demonstrated the importance of forecasting work, An said. [Text] [Beijing XINHUA in English 1613 GMT 18 Oct 86 OW]

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CSO: 4010/10

SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

BRIEFS

SHANGHAI ELECTRONIC RESEARCH CENTER--Beijing, 12 September (XINHUA)--An electronic research center passed an operational check on Thursday in Shanghai. Built by Fudan University, the center will engage in analysing and testing imported electronic equipment. [Text] [Beijing XINHUA in English 1058 GMT 12 Sep 86 OW] /12232

S&T UNIVERSITY MICROCOMPUTER COURSE--Hefei, 22 September (XINHUA)--A micro-computer training course for developing Asian countries opened today at the Chinese University of Science and Technology in Hefei, capital of east China's Anhui Province. The course is run jointly by the Italian International Center for theoretical physics under UNESCO and the Chinese Academy of Sciences. During the 1-month course, 24 experts from Italy, Switzerland and the United States will teach 80 students from 11 Asian countries. The first such micro-computer course was run in Sri Lanka in 1984. [Text] [Beijing XINHUA in English 1628 GMT 22 Sep 86 OW] /12232

CSO: 4010/1005

ION EXCHANGE OF URANIUM DISTRIBUTION OF URANIUM (IV) BETWEEN STRONG-BASE ANION-EXCHANGE RESIN AND SOLUTIONS OF HCl WITH ORGANIC SOLVENT

Lanzhou LANZHOU DAXUE XUEBAO (ZIRAN KEXUE BAN) [JOURNAL OF LANZHOU UNIVERSITY (NATURAL SCIENCE EDITION)] in Chinese Vol 22 No 2, 28 Jun 86 pp 53-59

[English abstract of article by Guo Hongyun [6753 4767 0061], et al.]

[Text] The distribution of U (IV) between a strong-base anion exchange resin and solutions of HCl with organic solvent has been studied. Using visible spectroscopy the authors studied the uranium (IV) species sorbed on an anion exchanger and the species which had been in the mixed solvents. The results of these investigations show that the distribution ratio of U (IV) increases obviously in the presence of ethanol and acetone, and the predominant uranium (IV) species sorbed on the anion resin is still  $UCl_6^{2-}$ . (Paper received 24 September 1984.)

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9717  
CSO: 4009/1016

DEFINING NONDETERMINISM IN SPACE BOUNDED TURING MACHINES

Lanzhou LANZHOU DAXUE XUEBAO (ZIRAN KEXUE BAN) [JOURNAL OF LANZHOU UNIVERSITY (NATURAL SCIENCE EDITION)] in Chinese Vol 22 No 2, 28 Jun 86 pp 10-14

[English abstract of article by Li Lian [2621 1670]]

[Text] The nondeterministic complexity of a Turing machine  $T$  is defined to be the number of the nondeterministic moves made by  $T$ . It is, in general, a function of the length of input. In this paper, we discuss the hierarchy problems with respect to the nondeterministic complexity and their relativization problems. In particular, it is proven that there exists an Oracle set  $E$  so that, in respect to  $E$ , there is an infinite hierarchy based on the non-deterministic complexity. (Paper received 25 January 1985.)

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Applied Mathematics

PERTURBATION-VARIATIONAL SOLUTION OF LARGE DEFLECTION OF RECTANGULAR PLATES  
UNDER UNIFORM LOAD

Chongqing YINGYONG SHUXUE HE LIXUE [APPLIED MATHEMATICS AND MECHANICS]  
in Chinese Vol 7 No 8, Aug 86 pp 675-688

[English abstract of article by Pan Lizhou [3382 4539 1352], et al., of  
Shanghai Institute of Applied Mathematics and Mechanics, Shanghai]

[Text] In this paper, von Karman's set of nonlinear equations for large deflection of rectangular plates is at first converted into several sets of linear equations by taking the central dimensionless deflection as the perturbation parameter, and then the sets of linear equations for plates with various ratios of length to width are solved with application of the variational method. The analytical expressions for displacements and stresses as well as formulas for numerical calculations are worked out. The figures for the maximum deflection-load and maximum stress, with a ratio  $\lambda$  of length to width as a parameter, are given in this paper. Through comparison, it is found that the results of this paper are in good accord with those of experiments. (Paper received 1 June 1985.)

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CHAPLYGIN EQUATION IN THREE-DIMENSIONAL NON-CONSTANT ISENTROPIC FLOW--THE  
THEORY OF FUNCTIONS OF COMPLEX VARIABLE UNDER DIRAC-PAULI REPRESENTATION AND  
ITS APPLICATION IN FLUID DYNAMICS (III)

Chongqing YINGYONG SHUXUE HE LIXUE [APPLIED MATHEMATICS AND MECHANICS]  
in Chinese Vol 7 No 8, Aug 86 pp 703-712

[English abstract of article by Shen Huichuan [3088 1920 1557] of the  
Department of Earth and Space Sciences, University of Science and Technology  
of China, Hefei]

[Text] This work is the continuation of the discussion presented in reference  
[1]. In this paper the author resolves the equations of isentropic gas  
dynamics into two problems: the three-dimensional non-constant irrotational  
flow (therefore, the isentropic flow, too), and the three-dimensional non-  
constant indivergent flow (i.e., the incompressible isentropic flow). The  
theory of functions of a complex variable under Dirac-Pauli representation  
and the Legendre transformation are applied, thus transforming these equations  
from two problems from physical space into velocity space, and obtaining two  
general Chaplygin equations. The general Chaplygin equation is a linear  
difference equation and its general solution can be expressed at most by  
the hypergeometric functions. Therefore, we can obtain the general solution  
of general problems for the three-dimensional non-constant isentropic flow  
of gas dynamics. (Paper received 1 May 1985.)

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ON THE PROBLEM OF PREVENTING BLOWING-UP AND QUENCHING FOR SEMILINEAR HEAT EQUATION

Chongqing YINGYONG SHUXUE HE LIXUE [APPLIED MATHEMATICS AND MECHANICS]  
in Chinese Vol 7 No 8, Aug 86 pp 713-718

[English abstract of article by Yan Ziqian [0917 1311 6197] of the Department of Mathematics, Jilin University, Jilin]

[Text] In this paper, the global existence of solutions to the IVP

$$u_t = \Delta u + g(t)f(u) \quad (t > 0, u|_{t=0} = u_0(x))$$

and the IBVP

$$u_t = \Delta u + g(t,x)f(u) \quad (t > 0, x(\Omega), u|_{t=0} = u|_{\partial\Omega} = 0)$$

is investigated. As was done in Reference [6], the introduction of factors  $g(t)$  or  $g(t,x)$  in the nonlinear term is to prevent the occurrence of blowing-up or quenching of solutions. It is shown in this paper that most of the restrictions on  $f$ ,  $g$  and  $u_0$  in the theorems contained in Reference [6] may be cancelled or relaxed, that the smallness of  $g$  is required only for large  $t$ , and that under certain conditions, controlling the initial state can prevent the blowing-up. (Paper received 3 May 1983.)

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## FEEDBACK TRACKING SYSTEM FOR ROBOT

Chongqing YINGYONG SHUXUE HE LIXUE [APPLIED MATHEMATICS AND MECHANICS]  
in Chinese Vol 7 No 8, Aug 86 pp 719-727

[English abstract of article by Zhang Hongtao [1728 3183 3447], et al., of  
the Department of Mechanics, Beijing University, Beijing]

[Text] The feedback information necessary for tracking is specified for a class of systems including robots. A feedback control method is proposed by which a robot can track and grasp an arbitrarily moving object in space. It differs from other methods in that it remains effective when it is impossible to know the orientation of the claw in advance. Its validity is verified by digital simulation. (Paper received 29 May 1985.)

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# THERMAL BENDING OF THICK RECTANGULAR PLATES OF BIMODULUS COMPOSITE MATERIALS

Chongqing YINGYONG SHUXUE HE LIXUE [APPLIED MATHEMATICS AND MECHANICS]  
in Chinese Vol 7 No 8, Aug 86 pp 739-745

[English abstract of article by Bai Zongfang [4101 1350 2455], et al., of  
Qingdao Chemical Engineering Institute, Qingdao]

[Text] Weighted residual solutions are presented for thermal bending of laminated composite plates. The material of each layer is assumed to be elastically and thermoelastically orthotropic and bimodular. The formulations are based on the thermoelastic version of the theory of the Whitney-Pagano laminated plate, which includes thickness shear deformations. The results are obtained for deflections and neutral-surface positions, and are found to be in good agreement with the closed-form solution. (Paper received 3 October 1985.)

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# RESEARCH ON VISCO-ELASTIC TYPE II RUPTURE WITH EXCITING AND ATTENUATION PROCESS

Chongqing YINGYONG SHUXUE HE LIXUE [APPLIED MATHEMATICS AND MECHANICS]  
in Chinese Vol 7 No 8, Aug 86 pp 759-767

[English abstract of article by Fan Jashen [5400 1367 0639] of Yunnan  
Institute of Technology, Kunming]

[Text] With the nonlinear Rayleigh damping formula, the author describes the exciting process when the rupture velocity is low and the attenuation process when the rupture velocity reaches a certain high value. Assuming the medium of the earth's crust is homogeneous and an isotropic linear Voigt visco-elastic body, the small parameter perturbation method is used to form a system of asymptotic linear equations from non-linear governing partial differential equations. These are solved by means of a generalized Fourier series with moving coordinates as its variables, thus transforming them into non-homogeneous Mathieu equations. The Mathieu equations are then solved by the WKBJ method. (Paper received 31 October 1983.)

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CSO: 4009/1014

Applied Sciences

ACCURATE DETERMINATION OF SMALL VARIATIONS FOR PARAMETERS OF POSITRON  
LIFETIME SPECTRA IN AMORPHOUS ALLOY

Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS]  
in Chinese Vol 10 No 5, Sep 86 pp 513-518

[English abstract of article by Xiong Liangyue [3574 5328 6885] of the  
Institute of Metal Research, Chinese Academy of Sciences]

[Text] A method for the accurate determination of the small variation in positron lifetime spectrum parameters is described using the example which determines the positron lifetime variations by means of annealing in amorphous material. A comparison between the differential distributions by simulation calculation and experimental measurement confirms that the mean positron lifetimes in metallic glass  $\text{Fe}_{67}\text{Co}_{18}\text{Si}_1\text{B}_{14}$  after annealing at 100°C, 300°C and 375°C are 0 ps, 4.0 ps and 4.3 ps respectively, shorter than those in the nontreated reference sample.

## PLASTIC SCINTILLATOR RESPONSE TO CHARGED PARTICLES

Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS]  
in Chinese Vol 10 No 5, Sep 86 pp 519-526

[English abstract of article by Zhou Dazhuang [0719 1129 8369] of the  
University of Science and Technology of China]

[Text] Plastic scintillators have many advantages and are widely used in particle physics. Research on plastic scintillator responses at both high energy and high electric charges is significant in experiments in high energy physics and cosmic ray physics. In addition to many important astrophysical results, the high energy cosmic ray experiments at the University of Chicago accumulate data for plastic scintillator responses to relativistic particles of high electric charges. This paper introduces the cosmic ray experiments mentioned above, presents data analysis results and discusses the nonlinear response of plastic scintillators.

BEHAVIOR OF PARTONS OF LARGE TRANSVERSE MOMENTUM IN DEEP INELASTIC SCATTERING

Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS]  
in Chinese Vol 10 No 5, Sep 86 pp 536-544

[English abstract of article by Wang Zhengben [3769 2973 2609] of Yunnan  
University]

[Text] The nucleonic states are represented by different configuration components in Fock space and the transverse momentum of partons is introduced as a degree of freedom into the structure function. In this way the author calculated the contribution of the components of the valent quarks and the non-valent quarks of the charm state to the ratio of the longitudinal and transverse cross sections of the virtual photons. An improved agreement with the experimental data is obtained. The causes of deviation of the Callan-Gross relation from the experimental data are pointed out.

# POSSIBLE FORM OF PION'S STRUCTURE FUNCTION

Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS]  
in Chinese Vol 10 No 5, Sep 86 pp 562-569

[English abstract of article by Long Ming [7893 7686] and Huang Tao [7806 3447] of the Institute of High Energy Physics, Chinese Academy of Sciences]

[Text] The pion's structure function behavior is discussed using the Fock state expansion of the hadronic wavefunction in QCD in this paper. As an example, the authors employ a model wavefunction of the Fock state in the light-cone and assume a Regge behavior of a weight function for high Fock states, obtaining a possible form of the pion's structure function. This form is consistent with experimental data of the pion's structure function.



EDDY-CURRENT EFFECTS OF BENDING MAGNET ON ELECTRON STORAGE RING DURING SLOW ACCELERATION

Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS] in Chinese Vol 10 No 5, Sep 86 pp 578-582

[English abstract of article by Zhang Wu [1728 2976], et al., of the University of Science and Technology of China; and Xu Jianming [1776 1696 6900] of the Institute of High Energy Physics, Chinese Academy of Sciences]

[Text] The magnetic field distribution of a C-type solid yoke bending magnet, a model magnet used on the Hefei synchrotron, is measured, and the eddy-current effects of a bending magnet on an electron storage ring during slow acceleration are investigated by a two coil induction approach. When slow acceleration exists, the possibility of applying a solid yoke bending magnet is verified.

APPROACH TO STRUCTURE FUNCTION FOR NUCLEON

Beijing GAONENG WULI YU HE WULI [PHYSICA ENERGIAE FORTIS ET PHYSICA NUCLEARIS]  
in Chinese Vol 10 No 5, Sep 86 pp 632-635

[English abstract of article by Long Ming [7893 7686] of the Institute of  
High Energy Physics, Chinese Academy of Sciences]

[Text] The structure function for the nucleon is discussed using the method  
given in a previous paper. The formulas are compared with the experimental  
data from low  $Q^2$  to high  $Q^2$ . The results show that the way the structure  
function for the nucleon is obtained from the hadronic wavefunction is a  
possible approach to investigating structure functions for the hadron.

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CSO: 4009/8

## CATALYTIC BEHAVIOR OF FERRIC COMPOUNDS IN OXIDATIVE DEHYDROGENATION OF BUTENE TO BUTADIENE

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese  
Vol 3 No 3, Jun 86 pp 8-12

[English abstract of article by Zhang Xiankuan [1728 2009 1401], et al., of Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences]

[Text] Five ferric compounds,  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub>,  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub>, ZnFe<sub>2</sub>O<sub>4</sub>, ZnFe<sub>2</sub>O<sub>4</sub>·20 percent  $\alpha$ -Fe<sub>2</sub>O<sub>3</sub> and ZnFe<sub>2</sub>O<sub>4</sub>·20 percent  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub>, used as catalysts for oxidative dehydrogenation of butene to butadiene, were prepared and identified by X-ray diffraction. The catalytic sites on the ferrite surface were studied by chemisorption and TPD of oxygen and n-butene. It was found that ZnFe<sub>2</sub>O<sub>4</sub> adsorbed more butene than did  $\alpha$ - and  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub>, with the latter two oxides adsorbing more oxygen than the former compound, and the mixtures of the Fe<sub>2</sub>O<sub>3</sub> isomers had greater ability for chemisorption of both butene and oxygen.

The reaction mechanism is discussed based on the different behaviors of these five ferric compounds acting as sorbents and oxygen-carriers in oxydative dehydrogenation of butene to butadiene or carbon dioxide. (Paper received 15 April 1985; finalized 11 November 1985.)

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SYNTHESIS AND CHARACTERIZATION OF POLYDIMETHYLSILOXANE-POLYPHENOLPHTHALEIN  
TEREPHTHALATE BLOCK COPOLYMER

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese  
Vol 3 No 3, Jun 86 pp 19-24

[English abstract of article by Sun Ji [1327 7535], et al., of Changchun  
Institute of Applied Chemistry, Chinese Academy of Sciences]

[Text] A series of polydimethylsiloxane-polyphenolphthalein terephthalate multi-block copolymers has been synthesized by using the low temperature solution condensation technique. The structural characterization of the block copolymers by IR,  $^1\text{H-NMR}$ , viscosimetry, TEM, etc., indicates that copolymers with controlled siloxane content can be obtained in high molecular weights. The copolymers can be either elastomeric or rigid, depending on the siloxane block length and its content. The copolymers show two-phase morphology, good mechanical properties, thermostability and film formability. (Paper received 24 April 1985; finalized 30 November 1985.)

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## SURFACE CHARACTERISTICS OF $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> POWDER

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese  
Vol 3 No 3, Jun 86 pp 30-34

[English abstract of article by Jin Shijiu [6855 1102 0046], et al., of the  
Institute of Chemistry, Chinese Academy of Sciences]

[Text] Dispersion of  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> powder in a polymer solution plays an important role in governing the recording density of magnetic recording materials. The wetting of the powders, disintegration of agglomerates and agglutination of particles are closely related to the surface characteristics of the  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> powder. In this paper, the wetting characteristics and apparent contact angles of the  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> powder in polar and non-polar liquids have been estimated by determining the penetration rates of these liquids through powders, as well as the sedimentative volume of powders in liquids. Based on Fowkes' theoretical assumption, the values of the surface tension of  $\gamma$ -Fe<sub>2</sub>O<sub>3</sub> powder have been calculated:  $\gamma_s^d = 24$  dyn/cm,  $\gamma_s^p = 17$  dyn/cm and  $\gamma_s = 41$  dyn/cm. (Paper received 28 April 1985; finalized 4 September 1985.)

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# ON THE MECHANISM OF THE REACTION BETWEEN VINYL ACETATE AND POLYBUTADIENYL-LITHIUM

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese  
Vol 3 No 3, Jun 86 pp 35-39

[English abstract of article by Shen Changjiang [3947 7022 3068], et al., of  
Beijing Institute of Chemical Technology]

[Text] The mechanism of the reaction between acetate and polybutadienyl-lithium was studied by using naphthalenelithium as the initiator in extracted naphtha solution. It was found that a coupling reaction occurs after vinyl acetate nad polybutadienyl-lithium have been brought together in an evacuated vessel accompanied by a simultaneous introduction of hydroxyl groups into the polymer chain. (Paper received 9 March 1985; finalized 10 May 1985.)

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# INFLUENCE OF HIGH-LOW JUNCTION IN EPITAXIAL p-Si ON PHOTOELECTRICAL CONVERSION EFFICIENCY

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese  
Vol 3 No 3, Jun 86 pp 56-60

[English abstract of article by Li Cheng [2621 3397], et al., of the Department of Chemistry, Shandong University]

[Text] An epitaxial p-Si(p<sup>+</sup>/p-Si) containing a semiconductive high-low junction was used as the photocathode in both photoelectrochemical voltaic and photo-assisted hydrogen evolution cells. The conversion efficiencies were 7.4 percent (V<sup>2+</sup>/V<sup>3+</sup> redox couple) and 7.8 percent (Co-W alloy decorated) respectively. The role of high-low junction in improving conversion efficiency is discussed. (Paper received 5 January 1985; finalized 26 February 1985.)

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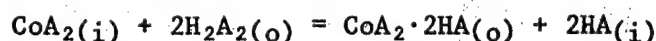
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STUDIES ON EXTRACTION KINETICS. V. EXTRACTION OF COBALT (II) WITH HDEHP BY SINGLE DROP METHOD

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese Vol 3 No 3, Jun 86 pp 61-66

[English abstract of article by Gai Huifa [5556 2585 3127], et al., of the Department of Chemistry, Shandong University, Jinan]

[Text] The kinetics and mechanism of the extraction of Co(II) from a sulphate solution with HDEHP in kerosene have been studied by means of the single drop method at 25°C. The experimental results indicate that the extraction process is controlled by the following interface reactions:



where (o) and (i) represent organic phase and interface respectively. The influences of sulphate, chloride and nitrate concentration on the extraction rate are also discussed. (Paper received 12 March 1985; finalized 24 August 1985.)

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## HIGH DAMPING BUTYL RUBBER FOR VIBRATION CONTROL

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese  
Vol 3 No 3, Jun 86 pp 67-69

[English abstract of article by Liu Jingjiang [0491 2529 3068], et al., of  
Changchun Institute of Applied Chemistry, Chinese Academy of Sciences]

[Text] ADR-06010 and ADR-06011 damping materials, unfilled and filled butyl rubber, have an inherently high damping capacity. Metal structures with these damping materials show excellent efficiency in vibration control. The results show that the bushings of ADR-06010 and ADR-06011 damping rubber have good isolation behavior. (Paper received 14 March 1985; finalized 15 January 1986.)

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INHIBITION EFFECT OF VANADIUM ON CARBON DEPOSITION ON ANTIMONY-IRON OXIDE CATALYSTS DURING AMMOXIDATION

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese Vol 3 No 3, Jun 86 pp 70-72

[English abstract of article by Li Guijia [2621 0964 3946], et al., of Changchun Institute of Applied Chemistry, Chinese Academy of Sciences]

[Text] The ammoxidation of propylene using an antimony-iron oxide catalyst was investigated by means of a fluidized bed reactor. The reactivity, amount of carbon deposited, and ESR spectrum data have been determined. The results indicate that a vanadium doped system resists the carbon deposition, stabilizing the structure of the catalysts, and accelerates the reoxidation rate of the reduced catalysts. (Paper received 15 May 1985; finalized 13 January 1986.)

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SYNTHESIS OF PHENYL NEODYMIUM (II) CHLORIDE AND ITS CATALYTIC ACTIVITY FOR  
DIENE POLYMERIZATION

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese  
Vol 3 No 3, Jun 86 pp 73-75

[English abstract of article by Qi Shuzhen [7871 3219 3791], et al., of  
Changchun Institute of Applied Chemistry, Chinese Academy of Sciences]

[Text] In this paper, the reaction of Nd metal vapor produced at high temperatures under a vacuum below  $10^{-4}$  mm Hg with chlorobenzene at  $-196^{\circ}\text{C}$ , giving phenyl neodymium chloride, has been preliminarily investigated. The composition of the product has been identified as  $\text{C}_6\text{H}_5\text{NdCl}$  by chemical analysis. The compound is a black crystalline, insoluble in organic solvents, stable at room temperature, extremely air-moisture sensitive, and pyrophoric in air.

The complex combined with  $\text{Al}(\text{i-Bu})_2\text{H}$  is able to polymerize diene to polybutadiene with cis-1,4 contents of 94.4 percent, trans-1,4 4.7 percent, 1.2 - 0.9 percent, and polyisoprene with cis-1,4 contents of 94.4 percent and 3,4- of 5.6 percent. (Paper received 24 April 1985; finalized 21 November 1985.)

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## UNUSUAL BEHAVIOR OF POLYETHYLENE TEREPHTHALATE IN CRYSTALLIZATION

Changchun YINGYONG HUAXUE [CHINESE JOURNAL OF APPLIED CHEMISTRY] in Chinese  
Vol 3 No 3, Jun 86 pp 79-80

[English abstract of article by Ma Ruisen [7456 3843 3947], et al., of the  
Institute of Material Science, Fudan University]

[Text] Spherulite growth rates and morphological structure changes during  
the crystallization of PET have been investigated using depolarimetry,  
polarized microscopy (PLM) and small angle light scattering (SALS).

The unusual behavior of spherulite growth rate curves under various conditions  
in the crystallization of PET have been observed by depolarimetry. A plot of  
depolarized light versus crystallization time indicates that there is a  
slight reduction in the crystallinity at higher temperatures. It is suggested  
for this phenomenon that partial melting and recrystallization of the  
crystalline occur at higher temperatures. In other words, imperfect  
crystallites are melted and changed into more perfect forms (better crystal  
lattice, larger crystal size). Observations with PLM confirm the suggested  
explanation.

Three types of spherulite patterns (usual, unusual and complex) in PET under  
different crystallization temperatures have been observed with PLM. The  
usual spherulites are formed at lower temperatures, while unusual spherulites  
are formed at higher temperatures. The results agree with Hv patterns of  
SALS. (Paper received 29 July 1985; finalized 28 November 1985.)

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CSO: 4009/1001

## INTERCONNECTION STRUCTURE FOR DATA FLOW COMPUTERS

Beijing JISUANJI YANJIU YU FAZHAN [COMPUTER RESEARCH AND DEVELOPMENT]  
in Chinese Vol 23 No 9, Sep 86 pp 2-10

[English abstract of article by Chen Guoliang [7115 0948 5328] of the  
University of Science and Technology of China]

[Text] In order to exploit the parallelism of data flow computers, software engineers must analyze the data-dependency expression as a one-dimensional program segment and translate it into a two-dimensional flow graph which can be easily executed in parallel. In addition, the architects must design a system structure which is suitable for executing a two-dimensional program graph and includes the architecture organization principle and packet communication structure suitable for asynchronous operation features. In this paper, from the point of view of an interconnection structure for data flow computers, the author studies the system organization principle of current data flow computers, discusses packet communication architecture suitable for data-driven operation features, and makes a case study of packet switch interconnection networks. Also, an evaluation is presented of various interconnection networks which can possibly be used by data flow computers. (Paper received in May 1985.)

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## QUERY PROCESSING OF RELATIONAL MICRO-DBMS WITH MULTI-OPTIMIZATION

Beijing JISUANJI YANJIU YU FAZHAN [COMPUTER RESEARCH AND DEVELOPMENT]  
in Chinese Vol 23 No 9, Sep 86 pp 24-30

[English abstract of article by Wang Nengbin [3769 5174 2430] and Zhu Qiang [2612 1730] of Nanjing Institute of Technology]

[Text] Some problems emerging from the design and implementation of the query-processing subsystem (QPSS) of the relational micro-DBMS NITDB are presented and analyzed in this paper. A query processing method with multi-optimization suitable especially for microcomputers is suggested. In addition to a brief introduction to the process of the query processing in the system, optimization through query transformation, optimization through preprocessing qualification and optimization through access strategy selection are discussed. Moreover, null value processing, view processing and some other problems are briefly discussed as well, and a number of implementation techniques are presented. The authors' views on query processing in the environment of microcomputers are also given. (Paper received in July 1985.)

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## MULTI-QUICK SORT

Beijing JISUANJI YANJIU YU FAZHAN [COMPUTER RESEARCH AND DEVELOPMENT]  
in Chinese Vol 23 No 9, Sep 86 pp 44-50, 34

[English abstract of article by Pan Si [3382 1835] and Jin Zhiqun [6855 1807 2938] of the Department of Computer Science, Nanjing University]

[Text] The average running time of the quick sort is less than that of all other currently known  $O(n \log n)$  sorting algorithms. Its average time is  $O(n \log n)$ , and its performance is  $O(n^2)$  in the worst case. The algorithm presented in this paper takes  $O(n \log m)$  to sort  $n$  elements, here  $m \in (1, [n/2])$ , and its performance is  $O(n)$  in the optimal case. The running results on the M-16 microcomputer are in agreement with the algorithm analysis given in the paper. (Paper received in September 1985.)

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DESIGN AND IMPLEMENTATION OF ACCESS METHOD LAYER OF NITDB

Nanjing NANJING GONGXUEYUAN XUEBAO [JOURNAL OF NANJING INSTITUTE OF TECHNOLOGY]  
in Chinese Vol 16 No 5, 20 Sep 86 pp 37-43

[English abstract of article by Wang Nengbin [3769 5174 2430], et al., of  
the Department of Computer Science and Engineering]

[Text] The design and implementation of the access method layer of NITDB, a multiuser relational DBMS being developed at Nanjing Institute of Technology, are presented. In NITDB, four types of storage structures are currently available: (1) sequential file structure, (2) clustering index sequential file structure, (3) secondary index file structure, and (4) index file structure especially designed for joining operations. In addition to the implementation techniques, the philosophy behind the design and implementation of each type of storage structure is also described in some detail. (Paper received 11 October 1985.)

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SOME THEOREMS RELATING TO THE EQUIVALENCE OF MICRO SQL QUERY STATEMENTS AND  
OPTIMIZATION VIA QUERY TRANSFORMATION

Nanjing NANJING GONGXUEYUAN XUEBAO [JOURNAL OF NANJING INSTITUTE OF TECHNOLOGY]  
in Chinese Vol 16 No 5, 20 Sep 86 pp 44-53

[English abstract of article by Wang Nengbin [3769 5174 2430], et al., of the  
Department of Computer Science and Engineering]

[Text] Micro SQL is a data language used in NITDB, a relational DBMS on a  
microcomputer. In order to optimize queries, some theorems relating to the  
equivalence of Micro SQL query statements are given in this paper by extending  
the idea presented in Kim's paper. Some of the results have been used in NITDB  
and an optimization strategy via query transformation was developed in NITDB  
to make query processing more efficient. (Paper received 1 July 1985.)

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微机软件开发与应用学术会议论文选》, 1986年5月。

# DEPLETION MODE MOSFET MODEL FOR SPICE II PROGRAM

Nanjing NANJING GONGXUEYUAN XUEBAO [JOURNAL OF NANJING INSTITUTE OF TECHNOLOGY]  
in Chinese Vol 16 No 5, 20 Sep 86 pp 54-61

[English abstract of article by Wei Tongli [7614 0681 4539], et al., of the  
Department of Electronic Engineering]

[Text] This paper analyzes the limitation cause of the SPICE II program used to simulate the characteristics of the depletion mode MOSFET and describes the characteristics of the depletion mode device in saturated and linear regions by using the saturated threshold voltage and linear threshold voltage. The paper also discusses the difference between the saturated and linear threshold voltage versus the back bias voltage, and presents a model of the depletion mode MOS transistor and a new parameter extraction method. The simulation results are in good agreement with the experimental data. (Paper received 18 October 1985.)

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APPLICATION OF MICROCOMPUTER DATABASE TO MANAGEMENT SYSTEM OF INSTRUMENTS  
AND APPARATUS IN INSTITUTIONS OF HIGHER LEARNING

Nanjing NANJING GONGXUEYUAN XUEBAO [JOURNAL OF NANJING INSTITUTE OF TECHNOLOGY]  
in Chinese Vol 16 No 5, 20 Sep 86 pp 135-138

[English abstract of article by Zhao Zhongxuan [6392 0112 1357], et al., of  
the Research Institute of Automation, Nanjing Institute of Technology]

[Text] A new generation of databases--DBASE III--is introduced by means of  
which a computer management system of instruments and apparatus has been  
developed. It possesses higher efficiency and stronger functions. This  
paper gives a technical illustration of the management system and an intro-  
duction to five functional modules and submodules which form the management  
system. (Paper received 10 October 1985.)

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CSO: 4009/1025

## KINETICS OF TYPE II PNEUMOCYTES AND ALVEOLAR MACROPHAGES IN EXPERIMENTAL SILICOSIS

Beijing ZHONGHUA JIEHE HE HUXIXI JIBING ZAZHI [CHINESE JOURNAL OF TUBERCULOSIS AND RESPIRATORY DISEASES] in Chinese Vol 9 No 3, 12 Jun 86 pp 129-132, 188

[English abstract of article by Si Turui [0674 1778 6904], et al., of Jinan University, Guangzhou]

[Text] The silicotic nodules of 50 rabbits' lungs were observed by electron microscopy after intratracheal instillation with 120 mg silica crystals per kg at days 2, 7, 15, 45, 90, 180, 250 and 360. The following observations were recorded:

Throughout the experimental process, neutrophils, type II pneumocytes, alveolar macrophages, monocytoids, fibroblasts, plasmacytes and lymphocytes were found in the silicotic nodules. During the formation of silicotic nodules, the cellular types not only changed continuously, but also depended on one another for their existence.

Tissue chopper of 16 rat lungs was evaluated by cytologic studies after intratracheal instillation with 40 mg of silica crystals at days 0, 15, 30 and 51 ~ 54. The kinetics of the number of type II pneumocytes were quantified by flow laser cytometry. The following results were recorded:

The number of type II pneumocytes and alveolar macrophages in lung tissue chopper from silica instilled rats result in elevated lung type II pneumocytes. The high peak is on the 15th day after silica instillation. These changes occur with the formation of the early stage silicotic nodules described above. (Paper received 19 November 1984; finalized 20 June 1985.)

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STUDIES OF INDUCTION OF  $\alpha$  AND  $\gamma$  INTERFERON IN CHRONIC HEPATITIS B PATIENTS

Beijing ZHONGHUA NEIKE ZAZHI [CHINESE JOURNAL OF INTERNAL MEDICINE] in Chinese  
Vol 25 No 6, 20 Jun 86 pp 347-349, 381-382

[English abstract of article by Zhang Limin [1728 0448 3046], et al., of  
Shanghai Jingan Central District Hospital]

[Text] Peripheral blood mononuclear cells of 11 chronic hepatitis B patients and 10 controls were studied for production of  $\alpha$  and  $\gamma$  interferons to new Castle Disease virus and concanavalin A. It was found that the titer of the  $\alpha$  interferon produced was significantly lower in the chronic hepatitis B patients than in the controls ( $4.2234 \pm 3.9305$  versus  $7.0411 \pm 6.6773$ ), whereas the titer of the  $\gamma$  interferon was similar, or slightly increased, in the patients when compared with that of the controls ( $5.3074 \pm 4.6271$  versus  $4.4228 \pm 3.3637$ ). In any individual patient, there was neither positive nor negative correlation between the production of the two types of interferon. Such data suggests that while the response of B and NK cells was decreased at the induction of interferon, T cells maintained their response to the induction of interferon. (Paper received 10 January 1985; finalized 10 March 1985.)

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# NATURAL KILLER ACTIVITY OF PERIPHERAL BLOOD IN PATIENTS WITH APLASTIC ANEMIA

Beijing ZHONGHUA NEIKE ZAZHI [CHINESE JOURNAL OF INTERNAL MEDICINE] in Chinese  
Vol 25 No 6, 20 Jun 86 pp 350-352, 382

[English abstract of article by Zhang Ruifa [1728 6904 4099], et al., of  
Wuhan Overseas Chinese Hospital]

[Text] Using  $^{125}\text{I}$ UdR labeled  $\text{K}_{562}$  cells as target cells, the natural killer cell (NK cell) activity of peripheral blood mononuclear cells was measured in 36 cases of aplastic anemia and 62 healthy volunteers. NK activity in normal individuals and in patients with aplastic anemia was  $50.20 \pm 17.68$  ( $\bar{X} \pm \text{SD}$ ) and  $23.66 \pm 17.40$  respectively. It was found that NK activity in patients with aplastic anemia was significantly lower than in normal individuals ( $P < 0.01$ ). The NK activity in convalescent cases of aplastic anemia ( $42.74 \pm 19.55$ ) was higher than that in untreated or therapeutically ineffective cases ( $P < 0.01$ ). It was shown that NK activity was relevant to the bone marrow cellularity of the patients. It was also found that the mean NK activity in hypercellularity cases was higher than that in hypocellularity cases. In addition, the NK activity in 13 cases of other hematologic disorders was measured, and the results showed that all of them had a lower level of NK activity. The authors conclude that NK activity may be used as an index for evaluating the general condition and hemopoietic function of patients with aplastic anemia. The authors also suggest that the susceptibility of aplastic anemia patients to infection, especially viral infection, is not only due to a decrease in the number of neutral granulocytes, but also to low NK activity. (Paper received 2 February 1985; finalized 12 August 1985.)

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CSO: 4009/1007

## STUDY OF PRIMARY STRUCTURE OF 27 TYPES OF HEMOGLOBIN VARIANTS IN CHINA

Tianjin ZHONGHUA XUEYEXUE ZAZHI [CHINESE JOURNAL OF HEMATOLOGY] in Chinese  
Vol 7 No 7, 30 Jun 86 pp 322-326, 382

[English abstract of article by Wang Hebi [3769 5440 4310], et al., of the  
Institute of Hematology, Chinese Academy of Medical Sciences]

[Text] A hemoglobinopathy cooperative group of 22 provinces and cities was organized, and a total of 1,165 probands of abnormal hemoglobin was found among 352,879 individuals. Structural analysis was carried out from 1981 to 1985. The primary structures of 27 variants, including 11  $\alpha$ -chains and 16  $\beta$ -chains, in 164 families were analyzed. They were all single amino acid substitutes. Four variants (Hb J Zizhong, Hb J Huaxi, Hb J Luhe and Hb G Xuchang) were found for the first time, and eight variants (Hb J Sardegna, Hb J Mexico, Hb Ankara, Hb D Iran, Hb Lufkin, Hb G Szuhu and Hb J Hacettepe) were found for the first time in China. The other variants were identical to those reported earlier. The geographical distribution of seven common variants was as follows: Hb G Coushatta, Hb G Taipei and Hb D Punjab were found predominantly in North China (85.0 percent, 68.0 percent and 100.0 percent respectively), but Hb E, Hb J Bangkok, Hb New York and Hb G Chinese were found mainly in South China (80.0 percent, 77.3 percent, 88.9 percent and 100.0 percent respectively). (Paper received 22 March 1986.)

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## MORPHOLOGICAL AND FUNCTIONAL STUDIES OF ERYTHROCYTES IN HEMOGLOBINOPATHIES

Tianjin ZHONGHUA XUEYEXUE ZAZHI [CHINESE JOURNAL OF HEMATOLOGY] in Chinese  
Vol 7 No 7, 30 Jun 86 pp 332-334, 383

[English abstract of article by Yang Xueyong [2799 1331 1661], et al., of the  
Institute of Hematology, Chinese Academy of Medical Sciences]

[Text] The components of hemoglobin were different in  $\alpha$ -thalassemia,  $\beta$ -thalassemia and HbE- $\beta$  thalassemia. There may be different morphological changes also. High density materials and enlarged nucleopores appeared in the erythrocytes of HbE- $\beta$  thalassemia. Inclusion bodies found in HbH erythrocytes were always attached to cell membranes. Less of bands I and II and deletion of bands III and IV could be found in the membrane protein of the  $\beta$ -thalassemia major erythrocytes and more of band VII could appear in HbH disease. The ratio of cholesterol and phospholipid in  $\beta$ -thalassemia was lower than in the control. The deformability defects were the characteristics of  $\beta$ -thalassemia and HbH disease. These caused a shortened survival time of HbH erythrocytes and a high death index in the spleen. These findings led to HbH splenectomy benefits. (Paper received 24 January 1986; finalized 14 April 1986.)

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CSO: 4009/1004



## TRAPPING OF HYDROGEN BY PRECIPITATE TiC IN LOW CARBON STEEL

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp A181-A188

[English abstract of article by Xian Aiping [0405 1947 1627], et al., of the  
Institute of Metal Research, Chinese Academy of Sciences, Shenyang]

[Text] The influence of Ti on hydrogen diffusion in low carbon steel has been studied by Davanathan's electrochemical method. The experimental results show that the strong trapping of hydrogen appears in the steel in which the Ti precipitated as dispersed TiC during aging after solution treatment. The trapping energies of the precipitation of dispersed TiC are evaluated as  $27.88 \pm 0.18$  and about 21 kJ/mol respectively before and after the  $\alpha \rightarrow \gamma$  phase transformation of the steel. However, these do not coincide with the value of 94.55 kJ/mol reported by Pressouyre. The lowest apparent diffusion coefficient of hydrogen in the steel Fe-0.2Ti-0.1C is found after being solution-treated at 1200°C and aged at 550°C. It seems to be caused by the low temperature precipitate TiC with a non-cubic structure and by many lattice vacancies which distort the local periodical potential fields around it. (Paper received 27 May 1985.)

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# EFFECT OF HYDROGEN ON YOUNG'S MODULUS AND COHESIVE ENERGY OF Ti-15Mo ALLOY

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp A189-A194

[English abstract of article by Wan Xiaojing [8001 2556 2589], et al., of  
the Institute of Metal Research, Chinese Academy of Sciences, Shenyang]

[Text] The effect of hydrogen on Young's modulus for  $\beta$ -titanium alloy Ti-15Mo has been investigated by both acoustic resonance and static methods. Results show that Young's modulus is continuously reduced by hydrogen. It seems to not be the result of hydride formation and damage caused by hydrogen charging, and the decrease of the modulus induced by hydrogen and its recovery are entirely reversible. The difference in cohesive energy among the specimens charged with various hydrogen contents has been measured by an ion microprobe mass analyzer. The cohesive energy is found to be significantly lowered by dissolved hydrogen. An explanation of the experimental results may be given by the decohesion theory of hydrogen embrittlement. Young's modulus decrease of the alloy induced by hydrogen may be attributed at least in part to the lowering of cohesive energy of the lattice, and this study may be considered to be a verification of the decohesion theory. (Paper received 22 May 1985.)

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## FATIGUE CRACK GROWTH FOR Ti-6Al-4V ALLOY IN WATER

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp A195-A200

[English abstract of article by Gao Shujun [7559 2885 3182], et al., of the  
Institute of Metal Research, Chinese Academy of Sciences, Shenyang]

[Text] The environmentally assisted fatigue crack growth for annealed  
Ti-6Al-4V alloy plates in distilled water has been studied using the fracture  
mechanics method. Fatigue crack growth rates  $\frac{da}{dN}$  were determined as a function  
of stress intensity factor range  $\Delta K$  from 20 to 45 MPa $m^{1/2}$ , temperature from  
273 to 353 K and frequency from 0.1 to 75 Hz at a load ratio of 0.11.  
Reference data were obtained in laboratory air at room temperature and a  
frequency of 10 Hz. Furthermore, SEM fractographic studies have been carried  
out to observe the fatigue fracture morphologies. The experimental results  
show that fatigue crack growth in water is enhanced when compared with that  
in air. The relationship between  $\frac{da}{dN}$  and  $\Delta K$  follows the Paris equation.

Fatigue crack growth rates were found to decrease with increasing temperature  
and to increase with decreasing frequency. The temperature dependence of  
crack growth rate at a frequency of 10 Hz can be described as:  $\frac{da}{dN} = Ae^{Q/RT}$   
 $(\Delta K)^{2.7}$ , where  $Q = 6.2$  kJ/mol. the fatigue fracture surface is composed of  
relatively flat regions and irregular fracture regions. The flat regions are  
covered with three kinds of fatigue striations: ductile striations, fissure  
striations and brittle striations. The irregular fracture regions are heavy  
plastic deformation areas, combined sometimes with small areas of striations.  
The ductile and fissure striations show an approximate one to one correspon-  
dence with the load cycles, whereas the spacing of the brittle striations is  
several times larger than the corresponding macroscopic growth rate.  
Enhancement of fatigue crack growth by water is believed to result from  
embrittlement by hydrogen that is produced by the reaction of water with the  
crack surface of the Ti alloy. The observed temperature and frequency  
effects on the fatigue crack growth rate can be explained in terms of a  
strain-induced hydride mechanism. Formation of strain-induced hydride is  
considered to be the rate-controlling process for crack growth. (Paper  
received 22 May 1985.)

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Eds. Sadananda, K.; Rath, B. B.; Michel, D. J., TMS-AIME, 1982, p. 71.

# DEPENDENCE OF HYDROGEN CONTENT ON HYDRIDE STRUCTURE AND YIELD STRENGTH OF TITANIUM PLATE

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp A201-A205

[English abstract of article by Wang Ruikun [3769 3843 0981], et al., of  
Beijing General Research Institute of Non-ferrous Metals]

[Text] The yield strength of pure Ti plate may be decreased at 540-650°C for specimens containing H within the range of 60 to 80 ppm, but it decreases no further with an increase in H. The sharp upper-lower yield point occurs on the stress-strain curve as the H content is less than 50 ppm at room temperature and 540°C, and disappears as H is over 50 ppm or at 650°C. Therefore, the maximum interaction energy between the H atom and dislocation in pure Ti is calculated to be 0.47 - 0.53 eV.

The morphology of hydride in pure Ti has been observed in the plate or needle shape. The hydride  $TiH_2$  was found to be the structure of BCT or fcc as the H content is less or more than 80 ppm respectively. It has also been observed under HVEM that the hydride in specimens containing 15 ppm H is of the BCT structure. (Paper received 3 May 1984; finalized 14 April 1985.)

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## INTERNAL FRICTION OF HYDRIDE PRECIPITATION IN Ta-H ALLOYS

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp A206-A212

[English abstract of article by Li Guangyi [2621 1639 5030], et al., of the  
Institute of Metal Research, Chinese Academy of Sciences, Shenyang]

[Text] The low frequency internal friction of cold-worked Ta wire with high purity was measured before and after hydrogen charging. It showed that a precipitation peak appears at higher temperatures than that of the H-SK peak, and at the same time the latter decreases in height after charging. An additional twist shows a remarkable influence on the precipitation peak. Aging at the temperature at which O atoms are able to migrate to the dislocations might completely eliminate the enhancement effect. The results indicate that the hydrides might preferentially precipitate on the dislocations. The precipitation peak is considered to be associated with the interaction between the dislocations and the hydrides. (Paper received 22 May 1985.)

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# IN SITU STUDY OF EFFECT OF HYDROGEN ON DEFORMATION AND FRACTURE BEHAVIOR IN Nb

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp A223-A228

[English abstract of article by Chen Lian [7115 1670], et al., of the Institute of Metal Research, Chinese Academy of Sciences, Shenyang]

[Text] SEM and optical microscope in situ examinations under tensile loading were performed on the effect of hydrogen upon the microprocess of deformation and fracture behavior in cathodic charged pure Nb. The Nb hydrides are found to precipitate on the {100} plane of the matrix. Most dendritic hydrides in orthorhombic needle shape are of the Widmanstatten structure. The slip lines and grain boundary hunches are obviously observed in the  $\alpha$ -solid solution matrix with hydrogen dissolved under tensile deformation. The microcracks initiated themselves predominantly along the slip lines and the deformation bands as well as the grain boundary oriented normally to the stress axis. The main crack propagation is the coalescence of microcracks in the vicinity of the crack tip and through the transgranular path. The  $\alpha$ -solid solution matrix with  $\beta$ -hydride is extremely brittle and of transgranular cleavage fracture under tension. The micro-patterns, featuring all brittle fractures and two  $\beta$ -hydrides, appear on the cleavage facets. The microcrack growths are present at the hydride/matrix interface. The crystal orientation of hydrogen embrittlement cleavage facets in pure Nb, the stress induced  $\beta$ -hydride and two typical hydrogen embrittlement mechanisms of pure Nb are also discussed. (Paper received 3 September 1984; finalized 4 March 1985.)

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# CRYSTALLOGRAPHY OF MARTENSITIC TRANSFORMATION IN Cu-26Zn-4Al SHAPE MEMORY ALLOY

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp A229-A235; A236-A242

[English abstracts of articles by Zhu Weiguang [2612 0251 0342], et al., of  
Shanghai Jiaotong University]

## [Text] I. Experimental and Phenomenological Theory

A study of the crystallography of martensitic transformation in a Cu-26Zn-4Al alloy by means of the phenomenological crystallographic theory is presented. The habit plane of the martensite calculated by a computer from W-L-R theory is found to be  $(\bar{1}, 7.71, 9.32)$  through the model of  $B_2$ -modified 9R monoclinic structure, which is consistent with that of the experimental results  $(\bar{1}, 7, 8)$ . (Paper received 15 June 1984).

## II. Application of Group Theory

From group theory, the irreducible representation and the 24 variants associated with the martensitic transformation of a Cu-26Zn-4Al alloy are obtained. The self-accommodating group is found to be  $D_{2h}$ , and the symmetry in one and the set of self-accommodating groups are analyzed. (Paper received 15 June 1984; finalized 27 October 1985.)

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# MÖSSBAUER SPECTROSCOPIC STUDY OF Nd-Fe-B PERMANENT MAGNETIC ALLOY

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp A251-A255

[English abstract of article by Qian Xiangrong [6929 4382 2837], et al., of  
Shanghai Institute of Iron and Steel Research]

[Text] The permanent magnets of the nominal composition  $\text{Nd}_x\text{B}_y\text{Fe}_{100-x-y}$ , with  $x=15$  or  $16$  and  $y=4-10$ , were investigated by means of the Mössbauer effect. The Mössbauer spectra may be resolved into the subspectra corresponding to the different phases. Mössbauer measurements show that the constituent phases of the alloy vary with its B content. The  $\alpha$ -Fe and  $\text{Nd}_2\text{Fe}_{17}$  are observed in the alloy without B; the tetragonal  $\text{Nd}_2\text{Fe}_{14}\text{B}$  occurs and  $\text{Nd}_2\text{Fe}_{17}$  disappears in that containing 4 at.-percent B; the Nd-rich and B-rich phases in addition to  $\text{Nd}_2\text{Fe}_{14}\text{B}$  exist and  $\alpha$ -Fe vanishes in that up to 7 at.-percent B, and the B-rich phase tends to increase predominantly while further increasing the B content. Six subspectra of the tetragonal phase correspond to the six non-equivalent Fe sites. It is pointed out that the  $j_2$  site possesses maximum hyperfine field and also maximum quadruple splitting. The preferential occupation of the  $j_2$  site by Fe atoms is critical for establishing the high anisotropy and remanence. (Paper received 17 December 1984; finalized 2 July 1985.)

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# EFFECT OF STRENGTH ON CORROSION FATIGUE BEHAVIOR OF LOW ALLOY STEELS IN ARTIFICIAL SEAWATER

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3, 18 Jun 86 pp A275-A282

[English abstract of article by Zheng Wenlong [6774 2429 7893], et al., of Shanghai Institute of Materials Research; Li Ge [2621 7245], et al., of Shanghai Baoshan Iron and Steel Works]

[Text] The corrosion fatigue (CF) and stress corrosion cracking (SCC) behavior of 34CrNi3Mo and 40CrNiMo steels with different strength grades and given various tempering treatments have been investigated in artificial seawater using fracture mechanics and electrochemical methods. Experimental results show that the SCC susceptibility of the steel in seawater is increased and the CF crack propagation rate,  $da/dN$ , is sharply raised with the increase of its YS. For steels of YS over 890 MPa, tempered less than 650°C, the  $da/dN$  vs  $\Delta K$  plot appears as a plateau, in which the  $\left(\frac{dN}{da}\right)_{II}$  is almost constant and its fracture surface is similar in shape to that of SCC. It is believed that the CF behavior is closely related to the SCC, and the SCC susceptibility of the steel is promoted under the CF condition. (Paper received 3 September 1984; finalized 4 March 1985.)

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# EXAFS MEASUREMENT OF METALLIC GLASS $\text{Cu}_{70}\text{Ti}_{30}$ ATOMIC NEIGHBORING STRUCTURE

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp B105-B110

[English abstract of article by Chang Longcun [1603 7893 1317], et al., of the  
Institute of Physics, Chinese Academy of Sciences, Beijing]

[Text] Copper K edge EXAFS spectrum of the metallic glass  $\text{Cu}_{70}\text{Ti}_{30}$  has been measured using the RU-1000 rotating anode X-ray system with a goniometer. Data analysis has been processed based on the EXAFS analysis program package written in the authors' laboratory. The distances, coordination numbers and Debye-Waller factors between the Cu atoms and neighboring atoms are determined by fitting the experimental data with the theoretical phase and backscattering amplitude. The chemical short range order and atomic neighboring structure feature of the metallic glass  $\text{Cu}_{70}\text{Ti}_{30}$  are discussed. (Paper received 28 August 1984.)

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## FRACTURE BEHAVIOR OF FUSED QUARTZ PARTICULATE COMPOSITES

Beijing JINSHU XUEBAO [ACTA METALLURGICA SINICA] in Chinese Vol 22 No 3,  
18 Jun 86 pp B111-B117

[English abstract of article by Wang Runze [3769 3387 3419], et al., of  
Luoyang Institute of Refractory Research]

[Text] The fracture behavior of the fused quartz particulate composites has been investigated. It shows that the volume fraction of particles dispersed in the matrix leads to direct dependencies of the elastic modulus and fracture surface energy, inverse changes in bending strength as well as increasing in an exponential relationship with fracture work and thermal shock damage resistance parameters. The decohesion of the weak interface between the particle and matrix may be considered to be the origin of toughening.  
(Paper received 25 June 1984.)

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CSO: 4009/1002

## 125-IODINE-LABELLED SECOND ANTIBODY SEPARATION RADIOIMMUNOASSAY FOR CYCLIC GMP

Shanghai HE JISHU [NUCLEAR TECHNIQUES] in Chinese No 10, Oct 86 pp 54-56, back inside cover

[English abstract of article by Fang Jun [2455 6511], et al., of Shanghai Chinese Medical College, and Wu Baihui [0702 0130 1920], et al., of Shanghai Institute of Chemical Reagents]

[Text] This paper describes iodine labelled radioimmunoassay for the cyclic GMP. Preparations of antigen, antibody and radioligand are described. A second antibody separation of simple high sensitivity method for the assay of cyclic GMP is presented.

The cross-reactivity of this cyclid GMP antiserum with cyclic AMP and GTP are 0.008 percent and  $3.1 \times 10^{-3}$  percent respectively.

Sensitivity of the method is 1.5 fmol cyclic GMP per tube. Recovery of the method is  $104.0 \pm 4.7$  percent and variety coefficient in batch is 2.8 percent.

Cyclic GMP content in the plasma of normal man is  $4.60 \pm 0.70$  pmol/ml. (Paper received 28 Oct 85.)

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CSO: 4009/3006

FINE STRUCTURE OF MAGNETIC MODES EXCITED IN YIG FILMS

Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 35 No 8, Aug 86  
pp 1072-1076

[English abstract of article by Zhang Pengxiang [1728 7720 5046], Hong Tao [3163 3447] and Cao Keding [2580 0344 1353] of the Institute of Physics, Chinese Academy of Sciences]

[Text] A series of magnetic modes was observed in LPE YIG films magnetized in a plane. These magnetic modes were excited by means of magnetostatic wave excitation and showed characteristics of equal spacing and slower attenuation than normal standing spin waves. Considering that the precession is elliptical and supposing there is inhomogeneity of magnetization in the film, the authors deduce a relationship between mode spacing and the magnetic parameters of YIG. Compared with experimental results, an inhomogeneity of 2.6-5.8 percent was deduced for the LPE YIG films.

# SUPERCONDUCTIVITY OF TWO-DIMENSIONAL GRANULAR FILMS

Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 35 No 8, Aug 86  
pp 1081-1086

[English abstract of article by Wang Wei [3769 3555], et al., of the Department of Physics, Nanjing University]

[Text] The authors measured the R-T characterization of various Sn granular film samples at low temperatures. The samples were prepared using the thermovaporization method in a vacuum chamber containing oxygen.

Because of the grains and grain sizes, and the distances between the grains are randomly distributed, the Josephson coupling and thermal excited electrons of the hopping process between the grains are not identical for different samples. Therefore, the experimental results may be recognized as the following three kinds of processes: (1) transition to zero resistance; (2) minimum resistance; and (3) metal-insulator transition.

## ELECTRON MICROSCOPY STUDIES ON INTERACTION BETWEEN CREEP AND FATIGUE

Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 35 No 8, Aug 86  
pp 1091-1094

[English abstract of article by Kong Qingping [1313 1987 1627], Wang Xiang [3769 5046], Zhou Hao [0719 3185] and Ni Qunhui [0242 5028 1979] of the Institute of Solid State Physics, Chinese Academy of Sciences, Hefei]

[Text] The mechanism of creep-fatigue interaction in a nickel base alloy (Nimonic 75 type) has been studied by transmission and scanning electron microscopy.

Experiments at 873 K and a stress amplitude of 392 MPa showed that the data of creep, fatigue and "creep combined with fatigue" obeyed approximately the linear cumulative law. Micrographs of fracture surfaces by SEM indicated that the rupture was intergranular. However, observations by TEM showed that the dislocation configurations within fractured specimens were quite different among creep, fatigue and "creep combined with fatigue." The authors believe that different dislocation configurations have different influences on the process of intergranular rupture, and the damages due to creep and fatigue are independent of each other. Consequently, linear interaction between creep and fatigue occurs macroscopically.

The present paper shows that TEM has great potential for revealing the mechanism of creep-fatigue interaction.

## STUDY OF INSTABILITY OF BISTABLE INJECTION LASERS

Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 35 No 8, Aug 86  
pp 1095-1101

[English abstract of article by Wang Shouwu [3769 1343 2976], Wang Qiming [3769 0796 2494] and Lin Shiming [2651 0013 7686] of the Institute of Semiconductors, Chinese Academy of Sciences]

[Text] The theory of instability for non-linear differential equations is applied to the rate equations of a bistable laser. It is found that there are three conditions that must be fulfilled in order for the system to be made stable. The first condition is automatically fulfilled in ordinary bistable lasers. The second and third conditions are related to the self-pulsation and bistable characteristics of the laser respectively. It has been shown that if the third condition is not fulfilled in a certain region, the linearized rate equation for a small-signal will have a monotonously increasing solution in that region. This means that the light power output curve has a negative slope region, which would result in a bistable character. On the other hand, if the second condition is not fulfilled, the linearized rate equation for the small-signal will have enhanced oscillating solutions. This means that the laser will self-oscillate as long as the third condition is fulfilled in that region. In addition, it is also shown that both the self-pulsation and the bistable behaviors of the laser are closely related to the non-linearity of the  $f(N)$  function, which is the necessary condition for having a linearized rate equation of the third order.

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